ORIGINAL ARTICLE

Morphologic Association of Female Lower Urinary Tract Symptoms with Anterior Vaginal Wall Relaxation in Primary Urodynamic Stress Incontinence

*Jenn-Ming Yang[1,2], Shwu-Huey Yang[3], Wen-Chen Huang[2,4,5]**

Background: To explore the morphologic association of female lower urinary tract symptoms with anterior vaginal wall relaxation in women with primary urodynamic stress incontinence.

Patients and Methods: The records of 782 women who were diagnosed with primary urodynamic stress incontinence and also had ultrasonographic evaluation of the lower urinary tract were retrospectively reviewed. Clinical data recorded in the database at the time of evaluation included demographic data, a symptom questionnaire, and results of a pelvic examination, urodynamic study and ultrasound cystourethrography. The symptom questionnaire addressed six categories of lower urinary tract symptoms, including urinary frequency, nocturia, urgency, urge incontinence, stress incontinence, and voiding difficulty. Bothersome severity of stress incontinence was assessed using a 6-point Likert scale. Morphologic characteristics of the lower urinary tract were evaluated at rest and during maximal Valsalva maneuver by introital ultrasonography.

Results: Of the 782 study subjects, 363 (46.4%) had urinary symptoms other than stress incontinence, and 82 (10.5%) did not report symptomatic stress incontinence. A significantly lower Ba point, determined by the pelvic organ prolapse quantification system, was found in subjects who did not report stress incontinence when compared with those who did ($p=0.017$). The symptom of stress incontinence was related to a greater straining bladder neck angle, whereas urgency was related to a smaller angle. Subjects who had urge incontinence had a significantly higher incidence of bladder neck funneling during stress than those who did not have urge incontinence ($p=0.033$). Subjects with stress incontinence had a significantly lower incidence of prolapsing bladder base than those without stress incontinence ($p=0.012$).

Conclusion: In subjects with primary urodynamic stress incontinence, the symptoms of urinary frequency, nocturia, and voiding difficulty were not associated with any morphologic characteristic, whereas urgency, urge incontinence, and stress incontinence were associated with specific morphologic features on ultrasonography.

[1]Division of Urogynecology, Department of Obstetrics and Gynecology, Mackay Memorial Hospital, [2]School of Medicine, Taipei Medical University, [3]School of Health and Nutrition, Taipei Medical University, [4]Department of Obstetrics and Gynecology, Cathay General Hospital, and [5]School of Medicine, Fu Jen Catholic University, Taipei, Taiwan.

**Address correspondence to:* Dr. Wen-Chen Huang, Department of Obstetrics and Gynecology, Cathay General Hospital, 280, Jen-Ai Road, Section 4, Taipei 106, Taiwan. *E-mail: huangwc0413@hotmail.com*

KEY WORDS — introital ultrasonography, lower urinary tract symptoms, primary urodynamic stress incontinence

■ *J Med Ultrasound* 2007;15(4):270–277 ■

Introduction

The goals in the management of lower urinary tract disorders are to identify the specific causes of urinary symptoms and to tailor therapy correctly, whether therapy is medical, behavioral or surgical in nature [1,2]. Treatment of underlying pathophysiology facilitates better treatment of symptoms. However, Abrams found little relationship between the symptoms women reported and findings on urodynamic tests [3]. Regardless of their poor correlation with urodynamic findings, lower urinary tract symptoms (LUTS) may impair quality of life [4]. Another means of investigating pelvic floor disorders is to evaluate the area morphologically with ultrasound, which is a noninvasive procedure that yields reproducible results [5,6]. The aim of this retrospective study was to investigate whether the presence of female LUTS in primary (i.e. previously untreated) urodynamic stress incontinence (USI) is associated with particular morphologic changes on either physical examination or ultrasonography.

Patients and Methods

We retrospectively reviewed a urodynamic database compiled from July 1998 to June 2004 and identified 1,019 subjects with primary, untreated USI. Of them, 996 patients (97.7%) had undergone anatomic assessment of the lower urinary tract by ultrasound. Of these 996 patients, 214 with diabetes mellitus, cerebrovascular disease, dementia, overt neurologic disease, pelvic surgery, occult USI (diagnosed after reduction of genital prolapse by Sims speculum), overflow incontinence or coexisting detrusor overactivity on urodynamic study were excluded from the analysis. Clinical data recorded in the database at the time of evaluation included demographic data, a symptom questionnaire, and results of a urinalysis, pelvic examination, urodynamic study and ultrasound cystourethrography. Sonographic scans and urodynamic examinations were obtained from consenting women participating in a local Ethics Committee-approved study of morphologic and functional correlates of USI.

Symptom questionnaire

Following the recommendation of the International Continence Society (ICS) [7], questions from the Urogenital Distress Inventory and the Incontinence Impact Questionnaire [8] were selected to constitute the interviewer-administered symptom questionnaire. This questionnaire addressed six topics regarding the storage and voiding functions of the lower urinary tract, including urinary frequency ("Do you experience frequent passage of urine every two hours or more than seven times during the day?"), nocturia ("Do you experience interruption of sleep more than once each night because of the need to micturate?"), urgency ("Do you rush to the toilet because of a sudden desire to void?"), urge incontinence ("Do you leak urine if you suddenly need to rush to the toilet?"), stress incontinence ("Do you leak urine while laughing, coughing, moving or heavy lifting?"), and voiding difficulty ("Do you experience difficulty in initiating micturition resulting in a delay in the onset of voiding?"; "Do you strain while voiding?"; "Do you feel that your bladder is incompletely emptied when voiding ceases?"). The answers to these questions consisted of "yes" or "no". If the answer was "yes", then the effect of an individual symptom on bothersomeness was

assessed by a 6-point Likert scale, ranging from 0 (not bothered by incontinence) to 1 (slightly bothered), 3 (moderately bothered), and 5 (severely bothered). The symptom of urinary frequency or nocturia reported on the questionnaire was documented by the use of a urinary diary. Despite the degree of bothersomeness, the presence of any symptom in a specific category was scored as a positive response to that category.

Pelvic examination

Patients were examined in the dorsal lithotomy position using a split speculum. Pelvic support was assessed when the patient was straining maximally. Site-specific analysis of pelvic organ prolapse was defined using the Baden–Walker halfway system (urethrocele, cystocele, uterine descent, enterocele, and rectocele) [9], the ICS pelvic organ prolapse quantification (POP-Q) system, or both [10]. The severity of pelvic organ prolapse was graded as stage 0 (no prolapse), I, II, III or IV.

Ultrasound cystourethrography

The lower urinary tract was assessed by introital sonography using a Toshiba SSA-260A (Toshiba Medical Systems, Tokyo, Japan) or a Voluson 730 (GE Medical Systems, Zipf, Austria) scanner and a 5.0 to 9.0 MHz endovaginal probe with an estimated bladder volume of 200 mL to 300 mL, with the patient lying supine. Morphologic characteristics of the lower urinary tract were evaluated at rest and during maximal Valsalva maneuver. These characteristics included measurement of the bladder neck position and observation of the opening (funneling) of the bladder neck, as well as the development of prolapsing bladder base during stress (Fig. 1) [11–13]. On ultrasound, a prolapsing bladder base was defined as prolapse or descent of the bladder base below the bladder neck at rest or on Valsalva. The position of the bladder neck was designated as the angle between the bladder neck–symphyseal line and the midline of the symphysis pubis. The rotational angle of the bladder neck was defined as the difference of the angle between resting and straining bladder neck positions [11–13].

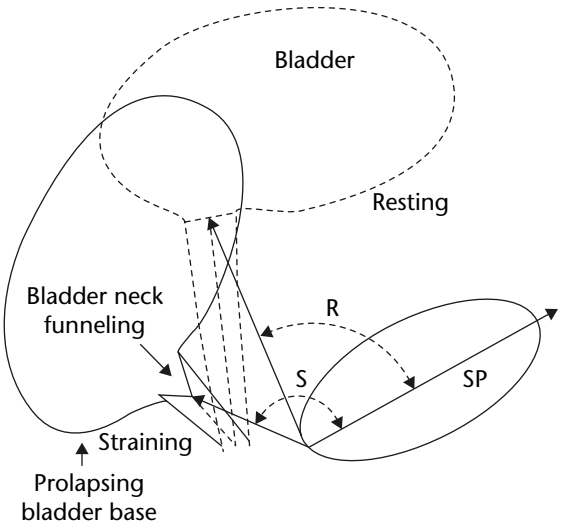

Fig. 1. *Quantitative and qualitative measurements on ultrasonography. The position of the bladder neck was measured using the angle between the bladder neck–symphyseal line and the midline of the pubic symphysis. During stress, bladder neck funneling was defined as opening of the bladder neck (proximal urethra); a prolapsing bladder base was defined as herniation or descent of bladder base below the bladder neck. S = straining bladder neck angle; SP = pubic symphysis; R = resting bladder neck angle.*

Urodynamic study

A full urodynamic study included a 1-hour pad test, spontaneous uroflowmetry, filling and voiding phase cystometry, and a urethral pressure profile on both resting and straining. Cystometry was performed at a filling rate of 80 mL/minute with the patient lying supine in a birthing chair. The intravesical pressure was measured with a fluid filled catheter (4.5 Fr), and the intra-abdominal pressure was measured transrectally with a latex rectal catheter. During filling, provocative maneuvers, such as coughing and the sound of running water, were performed. At the maximal cystometric capacity, the patient stood up, and a stress test followed, with the legs apart to the breadth of the shoulders. If the stress test was positive, the Valsalva leak point pressure (VLPP) was measured by asking the patient to strain, and the intravesical pressure was recorded at the point of visible urine loss. The lowest pressure obtained on two attempts was used. A voiding study was then carried out with the patient seated and the catheters still in place. After voiding, residual urine

volume was measured, and the bladder was refilled with 200 mL of 0.9% saline solution. A microtransducer catheter with two sensors 5 cm apart (Gaeltec, Dunvegan, Scotland) was introduced through the urethra with both sensors within the bladder oriented at the nine o'clock position. The rate of transducer withdrawal and chart recording was 2 mm/second. The resting and stress urethral pressure profiles were then measured with the patients sitting at 45°. Data were recorded continuously on an MMS UD-2000 multichannel recorder (Medical Measurement System, Enschede, The Netherlands). The curves for resting and stress urethral pressure profiles were divided into four quartiles along the functional profile length (Q1, 0–25%; Q2, 26–50%; Q3, 51–75%; Q4, 76–100%). We measured the highest pressure, the resting urethral closure pressure, and the pressure transmission ratios (the increment in urethral pressure on stress as a percentage of the simultaneously recorded increment in intravesical pressure) in each quartile. The VLPP values were reported as low VLPP (less than 60 cmH_2O), mid-VLPP (between 60 and 90 cmH_2O), high VLPP (greater than 90 cmH_2O) or negative VLPP (no urinary leakage) on Valsalva maneuver. The methods, definitions, and units conform to the recommendation of the ICS [7], except where specifically noted.

Statistical analysis

Statistical analysis was performed with SPSS 12.0 (SPSS, Inc, Chicago, Illinois, USA) for Windows. Demographic and morphologic variables, including pelvic examination and ultrasound cystourethrography, were selected as possible explanatory variables for LUTS. The association between each lower urinary tract symptom and explanatory variables was determined by using the *t* test or chi-square test where appropriate. Associations among LUTS were assessed by the McNemar test. Identification of the independent explanatory variables relating to the female LUTS was assessed by fitting multiple linear regression models (using the generalized linear model procedure in SPSS). A p value of <0.05 was considered statistically significant.

Results

A total of 782 women with primary USI were identified and constituted the study group. They had a mean age of 49.3 ± 11.6 years (range, 26–82 years), mean gravidity of 4.4 ± 2.2 (range, 0–12), mean parity of 3.0 ± 1.5 (range, 0–7), and mean body mass index of 24.3 ± 3.5 kg/m^2 (range, 18.7–33.1 kg/m^2). Of the 236 (30.2%) subjects who were postmenopausal, 70 (29.7%) were on hormone replacement therapy. Pelvic examination revealed stage I pelvic organ prolapse in 210 women (26.8%), stage II in 449 (57.4%), and stage III in 123 (15.7%).

Table 1 summarizes the patients' responses to the symptom questionnaire. Of the 782 study subjects, 371 (47.4%) had only one symptom category reported on the questionnaire, including 337 with stress incontinence, 16 with urinary frequency, 12 with voiding difficulty, four with nocturia, and two with urgency. Eighty-two (10.5%) did not report stress incontinence, while 363 (46.4%) had other symptoms in addition to stress incontinence. Of the 236 subjects with urgency, 116 (49.1%) did

Table 1. Summary of responses to the symptom questionnaire ($n=782$)*

	Incidence
Symptom	
Frequency	313 (40.0)
Nocturia	204 (26.0)
Urgency	236 (30.2)
Urge incontinence	139 (17.8)
Stress incontinence	700 (89.5)
Voiding difficulty	162 (20.7)
Number of symptoms reported	
One	371 (47.4)
Two	143 (18.3)
Three	95 (12.1)
Four	83 (10.6)
Five	61 (7.8)
Six	29 (3.7)

**Data are expressed as n (%).*

not report urge incontinence. With the exception of stress incontinence and urgency, as well as stress incontinence and urge incontinence, the various LUTS were significantly associated with each other. Stress incontinence was negatively associated with other symptoms, while the remaining symptoms were positively associated.

Table 2 shows the demographic and morphologic factors associated with each lower urinary tract symptom. Subjects with nocturia were significantly older than those without nocturia (52.8 ± 13.0 years *vs.* 47.9 ± 10.6 years; $p < 0.001$), whereas subjects with stress incontinence were significantly younger than those without stress incontinence (46.7 ± 11.1 years *vs.* 54.2 ± 13.9 years; $p = 0.002$). The frequency of nocturia significantly increased after menopause (40.3% *vs.* 26.1%; $p < 0.001$), while the frequency of stress incontinence significantly decreased after menopause (79.6% *vs.* 91.9%; $p < 0.001$). High parity was associated with nocturia and urge incontinence. Lower urinary tract symptom was not significantly associated with site-specific pelvic organ prolapse or its clinical severity with one exception: subjects who did not report stress incontinence had a significantly lower Ba point (measured on the POP-Q system) when compared with those who did have stress incontinence (0.25 ± 1.0 *vs.* −1.4 ± 0.9; $p < 0.017$). Symptomatic stress incontinence was associated with a greater straining angle of the bladder neck, but urgency was associated with a smaller straining angle. Subjects who had urge incontinence had a significantly higher incidence of bladder neck funneling on Valsalva than those who did not have urge incontinence (44.4% *vs.* 37%; $p = 0.033$). Subjects with stress incontinence had a significantly lower incidence of prolapsing bladder base during stress than those without stress incontinence (12.4% *vs.* 29.6%; $p = 0.012$).

Table 2. Association between various factors and lower urinary tract symptoms by uni- and multivariate analyses ($n = 782$)

Variables	Frequency	Nocturia	Urgency	UI	SI	Voiding difficulty	Bothersome severity of SI
Age	NS	(+); $p < 0.001$‖	NS	NS	(−); $p < 0.001$	NS	NS
Parity	NS	(+); $p = 0.008$	NS	(+); $p = 0.009$‖	NS	NS	NS
Menopause	NS	(+); $p < 0.001$	NS	NS	(−); $p < 0.001$	NS	NS
Aa point*	NS	NS	NS	NS	NS	NS	NS
Ba point*	NS	NS	NS	NS	(−); $p = 0.017$‖	NS	NS
Resting BN angle	NS	NS	NS	NS	NS	NS	NS
Straining BN angle	NS	NS	(−); $p = 0.011$	NS	(+); $p = 0.029$	NS	NS
Rotational angle of BN†	NS	NS	NS	NS	NS	NS	NS
BN funneling‡	NS	NS	NS	(+); $p = 0.033$	NS	NS	NS
Prolapsing bladder base§	NS	NS	NS	NS	(−); $p = 0.012$	NS	NS

**Measured using the pelvic organ prolapse quantification (POP-Q) system; †straining bladder neck angle–resting bladder neck angle; ‡opening of the bladder neck (proximal urethra) during stress; §prolapse or descent of the bladder base below the bladder neck at rest or on Valsalva; ‖independent variable on multivariate analysis. UI = urge incontinence; SI = stress incontinence; BN = bladder neck; NS = no significant association found; (+) = positive association; (−) = negative association.*

Discussion

In this study, 46.4% of the study subjects were bothered by other symptoms in addition to the subjective statement of stress incontinence. Epidemiologic studies have revealed an association between urinary incontinence and irritative or voiding symptoms [14,15], although these symptoms seem to be less bothersome than incontinence [16,17]. Usually, women who have objective evidence of stress incontinence also have symptoms. However, 10.5% of our study subjects did not report this symptom. We found that women who were older or postmenopausal were less likely to report stress incontinence, a finding also reported by other investigators [18,19]. Theoretically, a steady decline in estrogen production and increasing weakness of the pelvic floor after menopause should lead to an increase in urinary incontinence [20]. The severity of stress incontinence depends on the amplitude of rapid increases in intra-abdominal pressure [21]. A change in the physical environment (including a decrease in physical activity or concomitant medical conditions) in elderly or postmenopausal women could, in some cases, be an explanation for the discrepancy between expected symptomatology and what is actually reported [17].

Lower resting and straining bladder neck positions, as well as greater urethral mobility, are the ultrasonographic characteristics of primary USI [11]. It may be that study subjects who had objective but not subjective stress incontinence had a smaller straining bladder neck angle secondary to poor performance of a Valsalva maneuver during the ultrasound examination. They may also have had more stable support of the anterior vaginal wall. The incidence of prolapsing bladder base on ultrasound in primary USI had been reported to be around 40% [11]. A prolapsing bladder base (or cystocele in some studies [6]) with an open retrovesical angle does not affect voiding function [6]. However, a prominent prolapsing bladder base (also manifested as a lower Ba point on clinical examination) with an intact retrovesical angle may cause urethral kinking and voiding dysfunction [6], lessen the severity of urine loss, and therefore decrease the symptom of stress incontinence. An additional explanation may simply be reporting error. Women may forget, consider it to be of no importance, or be too embarrassed to note it. Regardless, the need to intervene should be based on a woman's desire for relief of symptoms, not on the findings on examination.

There were no significant morphologic correlates of urinary frequency, nocturia, or voiding difficulty. Urinary frequency may result from a change of lifestyle in a deliberate attempt to reduce the occurrence of incontinence. Voiding dysfunction may originate in the bladder or urethra, or both. Because it was not associated with any ultrasonographic abnormalities, voiding difficulty in our series might have been secondary to inefficient detrusor power or urethra obstruction of intramural or intraluminal type, or both. A history of voiding difficulty before incontinence surgery has been reported to be closely associated with the need for prolonged bladder drainage postoperatively [22]. Nocturia was strongly associated with demographic factors, especially age, a finding consistent with previous reports that nocturia increases with age and during menopause [4,23]. One of the drawbacks of our study was that we did not differentiate nocturnal frequency from nocturnal polyuria (> 35% of daily urine volume, which occurs despite a normal total daily urine volume).

Urgency seems to be a preceding symptom of urge incontinence. Morphologically, urgency was associated with a smaller straining angle of the bladder neck and urge incontinence with bladder neck funneling during stress. Assuming that urgency and urge incontinence have the same pathogenesis, patients with urgency seemed to have relatively better support of the bladder neck and, therefore, a smaller straining angle of the bladder neck. On the other hand, an opening of the bladder neck in urge incontinence indicates poorer support of the bladder neck [12]. Closure of the proximal urethra and bladder neck is dependent on the state of the surrounding muscles, innervation, and connective tissue [12,24]. Birth trauma, neurologic

lesions, and pelvic surgery may all contribute to bladder neck funneling [12,24]. Evidence suggests the clinical implications of bladder neck funneling at rest differ with varying bladder volume [24,25]. In one study, women who were continent did not have an open bladder neck at a volume of 200 mL [11]. Physiologically, funneling of the bladder neck precedes initiation of voiding. Pathologically, it may be associated with a facilitative reflex causing urinary frequency and urgency, intrinsic sphincter defect, and detrusor overactivity [11,12,25]. This study verifies that some LUTS are related to morphologic changes of the anterior vaginal wall, but some are not. Urgency and urge incontinence are associated with morphologic changes of the bladder neck. An incontinence procedure that fails to stabilize the bladder neck or correct bladder neck funneling may still leave the patient with associated symptoms which persist postoperatively [26]. Based on our findings, 17.8% to 30.2% of patients with stress incontinence simultaneously have urge incontinence or urgency or both and could potentially experience persistence or worsening of their urge symptoms after stress incontinence surgery without stabilizing the bladder neck.

There are several limitations to this study. Firstly, the Chinese version of the Urogenital Distress Inventory and the Incontinence Impact Questionnaire was not validated and might have cultural, racial, and linguistic dissimilarity. Thus, the symptom questionnaire used in this study may have the same inherent errors. It is important that, before application in a new population, a questionnaire instrument should be validated in the new setting [27]. Secondly, respondents may refuse to answer interview-directed questions they feel to be inappropriate [28]. Thirdly, our study did not exclude the confounding effects arising from coexisting prolapse in the middle or posterior vaginal compartments. This study, therefore, has the potential inability to generalize our findings to other populations.

In conclusion, our study demonstrated that a prolapsing bladder base could interfere with the subjective perception of the symptom of stress incontinence. Urgency and urge incontinence were associated with morphologic changes of the bladder neck on ultrasound but were not significantly associated with the symptom of stress incontinence. Urinary frequency, nocturia, and voiding difficulty were negatively associated with symptomatic stress incontinence but were not associated with any specific ultrasonographic characteristics.

Acknowledgments

This study was supported by Mackay Memorial Hospital Research (grant no. 9615) and National Science Council (grant no. NSC-95-2314-B-195-019-MY2).

References

1. Scarpero HM, Fiske J, Xue X, et al. American Urological Association Symptom Index for lower urinary tract symptoms in women: correlation with degree of bother and impact on quality of life. *Urology* 2003;61: 1118–22.
2. Melville JL, Miller EA, Fialkow MF, et al. Relationship between patient report and physician assessment of urinary incontinence severity. *Am J Obstet Gynecol* 2003; 189:76–80.
3. Abrams P. Urodynamics in clinical practice. In: Abrams P, ed. *Urodynamics*, 2nd edition. London: Springer, 1997:148–72.
4. Khullar V, Cardozo L. History and examination, In: Cardozo L, Staskin D, eds. *Textbook of Female Urology and Urogynecology*. London: ISIS Medical Media, 2002: 153–66.
5. Dietz HP, Haylen BT, Broome J. Ultrasound in the quantification of female pelvic organ prolapse. *Ultrasound Obstet Gynecol* 2001;18:511–4.
6. Dietz HP, Haylen BT, Vancaillie TG. Female pelvic organ prolapse and voiding function. *Int Urogynecol J Pelvic Floor Dysfunct* 2002;13:284–8.
7. Abrams P, Cardozo L, Fall M, et al; for Standardisation Sub-Committee of the International Continence Society. The standardisation of terminology in lower urinary tract function: report from the standardisation sub-committee of the International Continence Society. *Urology* 2003;61:37–49.

8. Shumaker SA,Wyman JF, Uebersax JS, et al. Health-related quality of life measures for women with urinary incontinence: the Urogenital Distress Inventory and the Incontinence Impact Questionnaire. *Qual Life Res* 1994;3:291–306.
9. Baden W, Walker T. Fundamentals, symptoms, and classification, In: Baden WF, Walker T, eds. *Surgical Repair of Vaginal Defects*. Philadelphia: JB Lippincott, 1992:51–62.
10. Bump RC, Mattiasson A, Bo K, et al. The standardization of terminology of female pelvic organ prolapse and pelvic floor dysfunction. *Am J Obstet Gynecol* 1996;75:10–7.
11. Yang JM, Huang WC. Discrimination of bladder disorders in female lower urinary tract symptoms on ultrasonographic cystourethrography. *J Ultrasound Med* 2002;21:249–55.
12. Huang WC, Yang JM. Bladder neck funneling on ultrasound cystourethrography in primary stress urinary incontinence: a sign associated with urethral hypermobility and intrinsic sphincter deficiency. *Urology* 2003;61:936–41.
13. Yang JM, Yang SH, Huang WC. Dynamic morphologic changes in the anterior vaginal wall before and after laparoscopic Burch colposuspension in primary urodynamic stress incontinence. *Ultrasound Obstet Gynecol* 2005;25:289–95
14. Schmidbauer J, Temml C, Schatzl G, et al. Risk factors for urinary incontinence in both sexes. *Eur Urol* 2001;39:565–70.
15. Lin HH, Torng PL, Sheu BC, et al. Urodynamically age-specific prevalence of urinary incontinence in women with urinary symptoms. *Neurourol Urodyn* 2003;22: 29–32.
16. Sommer P, Bauer T, Nielsen KK, et al. Voiding patterns and prevalence of incontinence in women. A questionnaire survey. *Br J Urol* 1990;66:12–5.
17. Moller LA, Lose G, Jorgensen T. The prevalence and bothersomeness of lower urinary tract symptoms in women 40–60 years of age. *Acta Obstet Gynecol Scand* 2000;79:298–305.
18. Yarnell JWG, Voyles GJ, Richards CJ. The prevalence and severity of urinary incontinence in women. *J Epidemiol Community Health* 1981;35:71–4.
19. Hunskaar S, Vinsnes A. The quality of life in women with urinary incontinence as measured by the sickness impact profile. *J Am Geriatr Soc* 1991;39: 378–82.
20. Kelleher C. Epidemiology and classification of urinary incontinence, In: Cardozo L, ed. *Urogynecology*. London: Churchill Livingstone, 1997:3–23.
21. Bump RC. The urodynamic laboratory. *Obstet Gynecol Clin North Am* 1989;16:795–816.
22. Stanton SL, Ozsoy C, Hilton P. Voiding difficulties in the female: prevalence, clinical and urodynamic review. *Obstet Gynecol* 1983;61:144–7.
23. FitzGerald MP, Butler N, Shott S, et al. Bother arising from urinary frequency in women. *Neurourol Urodyn* 2002;21:36–41.
24. Kennelly MJ, McGuire EJ. Intrinsic sphincter deficiency, In: O'Donnell PD, ed. *Urinary Incontinence*. St Louis: Mosby, 1997:207–13.
25. Versi E. The significance of an open bladder neck in women. *Br J Urol* 1991;68:42–3.
26. Skala C, Emons G, Krauss T, et al. Postoperative funneling after anti-incontinence surgery: a prognostic indicator? Part 1: colposuspension. *Neurourol Urodyn* 2004;23:636–42.
27. Harvey MA, Kristjansson B, Griffith D, et al. The Incontinence Impact Questionnaire and the Urogenital Distress Inventory: a revisit of their validity in women without a urodynamic diagnosis. *Am J Obstet Gynecol* 2001;185:25–31.
28. Shaw C, Matthews RJ, Perry SI, et al; for Leicestershire MRC Incontinence Study Team. Validity and reliability of symptoms of storage abnormality: the Leicester Urinary Symptoms Questionnaire. *BJU Int* 2002;90: 205–15.